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MODEL SKENARIO PENGGUNAAN LAHAN DALAM MITIGASI POTENSI BANJIR DI DAS CISADANE

Yuda Vatra Erlangga[1], Emma Soraya[2], Hero Marhaento[2]

INTISARI

DAS Cisadane dengan luas ± 153.600 Ha merupakan salah satu DAS Prioritas Nasional dan belum mampu merespons dinamika hidrologi DAS dengan baik. Beberapa penelitian terdahulu telah melakukan pemodelan banjir pada DAS Cisadane namun hasil yang didapat masih kurang akurat dan belum diintegrasikan dengan data proyeksi curah hujan dan evaluasi skenario intervensi pencegahan banjir yang masih minim dilakukan. Berdasarkan hal tersebut maka penelitian ini bertujuan untuk 1) memodelkan sebaran spasial potensi banjir di DAS Cisadane; dan 2) memodelkan skenario penggunaan lahan terbaik untuk mitigasi banjir di DAS Cisadane.

Penelitian ini mengintegrasikan pemodelan hidrologi dan hidrolika untuk memodelkan banjir aktual dan potensial berdasarkan data proyeksi curah hujan berbasis perubahan iklim. Data lain yang juga digunakan adalah tutupan lahan, DEM, tekstur tanah, dan debit. Pemodelan hidrologi dilakukan pada aplikasi *Hydrologic Engineering Center's Hydrologic Modeling System* (HEC-HMS) untuk memodelkan debit air. Dilanjutkan dengan pemodelan hidrolika menggunakan aplikasi *Hydrologic Engineering Center's River Analysis System* (HEC-RAS) untuk memodelkan potensi banjir yang terjadi. Model hidrologi dan hidrolika dikalibrasi dan divalidasikan menggunakan data debit dan kejadian banjir historis tahun 2019 hingga 2024. Hasil pemodelan banjir digunakan untuk menyusun model berbagai skenario penggunaan lahan secara bertahap untuk skenario terbaik dalam mengurangi potensi banjir.

Model simulasi debit dan spasial potensi banjir yang dihasilkan akurat yang ditunjukkan dengan nilai RSR, NSE, dan PBIAS yang berturut turut 0,68, 0,52, dan -4,88% dan measure of fit sebesar 78,03. Potensi peningkatan luas banjir hingga 70,41% apabila dibandingkan antara skenario baseline dengan kondisi aktual. Untuk mengurangi indeks bahaya banjir direkomendasikan skenario berupa penambahan areal hutan di hulu dan sempadan sungai seluas 8.921,37 Ha, penerapan agroforestri di kebun dan pertanian lahan kering seluas 34.181,85 Ha, dan penerapan *Blue-Green Infrastructure* di kawasan permukiman. Skenario tersebut dapat menurunkan potensi banjir dari luas 21.722,20 ha menjadi 12.513,48 Ha, atau berkurang 42%

Kata Kunci: Banjir, Cisadane, Hidrologi, Hidrolika, HEC-HMS, HEC-RAS

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LAND USE SCENARIO MODELING FOR FLOOD POTENTIAL MITIGATION IN THE CISADANE WATERSHED

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ABSTRACT

The Cisadane Watershed, covering an area of ±153,600 Ha, is designated as one of the National Priority Watersheds, yet it has been unable to adequately respond to its internal hydrological dynamics. Although several previous studies have modeled floods within the Cisadane Watershed, the resulting outputs lack precision and have not yet integrated climate change-based rainfall projection data, alongside a noticeable scarcity in evaluating flood prevention intervention scenarios. Driven by these limitations, this study aims to: 1) model the spatial distribution of flood vulnerability in the Cisadane Watershed; and 2) simulate the optimal land use scenario for flood mitigation within the watershed.

This research integrates hydrological and hydraulic modeling to simulate actual and potential floods utilizing climate change-driven rainfall projection data. Additional datasets employed include land cover, Digital Elevation Models (DEM), soil texture, and discharge data. Hydrological modeling was executed using the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) software to simulate river discharge. This was subsequently coupled with hydraulic modeling using the Hydrologic Engineering Center's River Analysis System (HEC-RAS) software to map the resulting flood hazards. Both models were calibrated and validated using historical discharge data and flood events spanning from 2019 to 2024. The flood simulation outputs were then utilized to progressively develop various land use scenarios to identify the most effective strategy for minimizing flood potential.

The resulting discharge simulations and spatial flood hazard models demonstrated high accuracy, as indicated by the RSR, NSE, and PBIAS values of 0.68, 0.52, and -4.88%, respectively, alongside a measure of fit of 78.03. The analysis reveals a potential increase in flood inundation area by up to 70.41% when comparing the baseline projection scenario against current actual conditions. To reduce the flood hazard index, this study recommends an integrated scenario consisting of: expanding forested areas in upstream regions and riparian zones by 8,921.37 Ha; implementing agroforestry across plantations and dryland agriculture covering 34,181.85 Ha; and deploying Blue-Green Infrastructure within residential areas. This optimal scenario is capable of reducing the potential flood inundation area from 21,722.20 Ha to 12,513.48 Ha, achieving a substantial 42% reduction.

Keywords: Flood, Cisadane, Hydrology, Hydraulic, HEC-HMS, HEC-RAS

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